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Experiments on the ALKALINE SUBSTANCES *uſed in* BLEACHING, *and on the* COLOURING MATTER *of* LINEN-YARN.

By RICHARD KIRWAN, *Eſq;* F. R. S. *and* M. R. I. A.

SECTION I.

BLEACHING being one of thoſe arts which conſiſt in ſcarce any thing elſe than a particular application of ſome of the general principles of chymiſtry, it might be expected that the knowledge of the inſtruments it employs would keep pace with the progreſs and improvements of that ſcience to which it is ſubordinate, and ſo much the more as the nature of alkaline ſubſtances in general, which are its proper inſtruments, has been in great meaſure explained by the celebrated Doctor Black upwards of thirty years ago: Yet it has ſo happened, that on a late occaſion, when a ſcarcity of theſe ſaline ſubſtances, imported from foreign countries, unhappily prevailed in this kingdom, it was ſeriouſly queſtioned whether their place could be ſupplied by materials manufactured Read April 4, 1789.

manufactured at home. In the courſe of this diſcuſſion, it evidently appeared, from the contradictory teſtimonies of many of the principal bleachers, that however they might excel in that art, when well provided with the inſtruments they employ, they were but little acquainted with the general agency of the inſtruments themſelves and their reſpective powers, or even with the moſt advantageous and œconomical method of employing them. To elucidate theſe points by an analyſis of ſome of the different ſubſtances employed by bleachers, and by giving a ſure method of diſtinguiſhing the relative powers of every ſaline ſubſtance they may uſe, together with an account of the beſt method of obtaining them, as well as of adapting them to the purpoſe of bleaching, is the object of this paper. This taſk, which I have impoſed upon myſelf ſolely with a view to the utility of the public, requires no ingenuity, and might have been long ago well executed by many others, if chymiſtry, which has ſo many votaries of the higheſt rank in the moſt civilized parts of Europe, had been more known and cultivated in this country, which perhaps of all others ſtands moſt in need of its aſſiſtance.

SECTION II.

BARILHA.

Of this ſubſtance there are ſeveral ſorts made of different plants*, but the beſt is that formed near Alicant, at a diſtance from the ſea, by the combuſtion of a plant called by the inhabitants *barilha*, and deſcribed by Juſſien in the memoirs of the academy of Paris for 1717, under the name of *kali hiſpanicum, ſupinum annuum, ſedi foliis brevibus.* It ſeems to be claſſed by Linneus under the *pentandria digyn*, by the name of *ſal ſola vermiculata fruteſcens foliis ovatis acutis carnoſis*, and ſhould carefully be diſtinguiſhed from the various kinds of *ſalicornia* which he ranges under the title of *monandria monogyna;* and alſo from other plants which he calls *chænopodia*, which yield an alkali, but leſs pure than the *ſalſola.* Theſe plants being dried to the ſame degree as hay, are burned in pits nearly as kelp is with us, the aſhes and ſalt run into a greyiſh blue maſs, which is the barilha †. The beſt ſort is here called *ſweet barilha.*

The ſweet barilha which I examined was moſt obligingly preſented to me by Mr. Byrne, an eminent merchant of this city. It was of a bluiſh colour, covered over with a ſaline powder

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[*] See Colonel Conyngham's letter, report of the committee of the houſe of commons of Ireland, 1788, p. 87.

[†] And by the French *ſoude*, as being employed in ſoldering metals.

exceedingly hard, and had a ſmart alkaline taſte. When broken it looked black in the fractured part, and viſibly contained pretty large pieces of charcoal.

To find the proportion of fixed air in this ſubſtance, having reduced a quantity of it to fine powder, I poured on an ounce of it a ſufficient quantity of marine acid, and found it to loſe by the action of this acid 80 grains of its weight, conſequently one pound troy of this ſubſtance contains 960 grains of fixed air, (mixed with a little that had an hepatic ſmell) that is exactly $\frac{1}{6}$ of its weight. Other parcels contained ſomewhat more, and others ſomewhat leſs.

As this ſubſtance evidently contained ſome parts that were ſoluble in water and ſome that were inſoluble therein, to diſcover the weight of each I poured on one pound of it reduced to fine powder thirteen pounds of water moderately hot, ſucceſſively; this water had previouſly been boiled and filtered, and contained no other impurity than a ſlight trace of common ſalt. This quantity of water was neceſſary to exhauſt all the ſoluble matter in the barilha.

The ſolutions were taken in ſix different portions, none of them betrayed the ſmalleſt mark of ſulphur, of which I was aſſured by trying them with the nitrous ſolution of ſilver, nor did the Pruſſian alkali diſcover any veſtige of iron.

By eighteen ſucceſſive evaporations and cryſtallizations, I obtained 4881 grains of ſaline matter, the different ſpecies of which I ſhall preſently mention, and 2903 of inſoluble matter.

It may at firſt ſight appear extraordinary that the ſaline matter and the inſoluble part ſhould weigh more than the pound of barilha that ſeemed to afford them, for this amounts only to 5760 grains, and the two former weigh 7784 grains; but it ſhould be conſidered that theſe products were obtained not from the barilha alone, but from the barilha and the water in which the ſalts were diſſolved, whoſe cryſtals retained a great quantity of it, and alſo from the air to which the ſolutions were expoſed, and which they abſorbed in large proportion.

As the quantity of the inſoluble matter was ſubject to no ſuch deceptive appearance, I began by examining the weight of that, for this being ſubtracted from 5760 grains neceſſarily determined the true weight of the ſaline part, and as the ſtate in which the ſaline part exiſts in barilha depends in ſome meaſure of the earths and charcoal with which it is united, as well as the moſt advantageous method of uſing it, I examined the nature and quantity of theſe very minutely.

Having therefore dried the inſoluble matter for a conſiderable time in a low heat until it appeared as dry as the barilha itſelf, and having found its weight in that ſtate to amount to 2903 grains or 6,04791 ounces, I took one ounce of it, and drying it in a heat little below redneſs, found it to loſe 38 grains of moiſture.

Another ounce of the ſame reſiduum being treated with dilute marine acid loſt 125,5 grains of its weight, and this loſs expreſſes the quantity of fixed air contained in it.

ANOTHER ounce being calcined in a white heat for about one hour loſt 200 grains of its weight, and on repeating this experiment I found the loſs amount to 199 grains.

LASTLY, on the 281 grains which remained after this experiment I poured dilute marine acid, and found the quantity of fixed air to be 106 grains.

HENCE I deduce the weights of the ſeveral ſubſtances diſſipated by the calcination of an ounce of the inſoluble reſiduum of the barilha.

1ſt, The weight of the fixed air loſt was 125,5—106=18,5 grains.

2dly, The loſs of moiſture was 38 grains.

3dly, The loſs of the fixed air and moiſture amounted together to 56,5 grains. This deducted from the intire loſs, that is from 199 grains, gives the loſs ariſing from the combuſtion of the charcoal, and conſequently its quantity, 199—56,5=142,5 grains.

I NEXT proceeded to examine the fixed incombuſtible part that remained after the above calcination. On the 279 grains of this, which remained after the calcination of an ounce of the inſoluble part, I poured a quantity of diſtilled vinegar, whoſe ſpecific gravity in the temperature of 62° was 1,008, and digeſted that reſiduum therein for ſixteen hours in a heat little more than 100°. After edulcoration and deſiccation I found the weight of what remained undiſſolved to amount to 63 grains. Upon this experiment I reaſoned thus: 281 grains of a reſiduum of this ſort contained 106 grains of fixed air, therefore the 279 grains ſubjected to the vinegar in this experiment muſt have contained 105,24 which were diſſipated by the action of the acid; there remained therefore of mere earth only 173,76; but of theſe 63 eſcaped the action of the acid, therefore there were diſſolved 110,76. And as diſtilled vinegar can act only on calcareous and muriatic earth, (the barytic being not expected) the 110,76 that were diſſolved muſt have conſiſted of either or both of theſe, and the undiſſolved 63 grains muſt have been argillaceous or ſiliceous.

To determine the firſt point I diſtilled in a glaſs retort the acetous ſolution, which was very voluminous, until no more than about four pints remained. During the diſtillation ſome earth was depoſited, which when dried in a red heat amounted to 4 grains; this I re-diſſolved, and finding it precipitable by cauſtic volatile alkali judged it to be magneſia. I then took as much of the acetous ſolution as amounted to $\frac{1}{6}$ of the whole, and pouring cauſtic volatile alkali upon it, obtained nearly 3 grains or more exactly 2,83 grains of magneſia precipitated by the alkali. Whence I concluded the whole ſolution to contain 17 grains, to which adding the 4 grains depoſited, we have the intire quantity of magneſia diſſolved by the vinegar =21 grains, and conſequently the remainder of 110,76 grains, namely 89,76, muſt have been calcareous earth.

I ALSO examined the quantity of this earth in another manner; to the $\frac{5}{6}$ of the acetous ſolution that remained I added gradually vitriolic acid, whoſe ſpecific gravity was 1,463, as long as any precipitation appeared to take place, then pouring off the vinegar I edulcorated the reſiduum, and having dried it found it to weigh 240 grains, and conſequently if the whole acetous ſolution had been uſed, the reſulting ſelenite would have weighed 288 grains: Now 100 grains of ſelenite contain 32 of calcareous earth, therefore 288 grains contain 92,16 grains, which differs inconſiderably from the former determination.

Lastly, the 63 grains which eluded the action of the acetous acid being digeſted in ſpirit of ſalt, left a reſiduum of 41,3 grains, which therefore were ſiliceous; the remainder not being precipitable by the vitriolic acid was conſequently argillaceous earth; hence the quantities of theſe ingredients in 480 grains of the inſoluble part of barilha were found to be

	Grains.	And in the whole inſoluble part. Grains.
Fixed air	125,5	759
Water	38	229,82
Charcoal	142,5	861,82
Calcareous earth	89,76	542,86
Muriatic	21	127
Argillaceous	21,7	131,23
Siliceous	41,3	249,58
	479,76	2901,31
Error	,24	1,69
	480,00	2903,00

I NOW return to the ſoluble part of the barilha, which neceſſarily amounted only to 2857 grains, as 5760—2903=2857.

IN the firſt place I obtained 4213 grains of pure cryſtallized mineral alkali, but theſe cryſtals are known to contain but $\frac{1}{5}$ of real alkaline ſubſtance, the remainder of their weight being fixed air and water of cryſtallization, therefore one pound of barilha contains but 842 grains of pure real alkali.

BESIDES this I alſo obtained 127 grains of a mixture of mineral alkali and common ſalt, which I could not eaſily ſeparate, and 346 grains of a mixture of vegetable and mineral alkali, with a ſmall proportion of extractive matter, and ſome digeſtive ſalt, as I believe; this maſs conſtantly attracted moiſture. I weighed it hot and dry, but forgot to examine the portion of fixed air it contained; it could not be leſs nor much more than 28 per cent. and therefore this maſs contained about 250 grains of mere alkali.

THESE ſolutions, and particularly the laſt portions, afforded alſo 125 grains of Glauber's ſalt and 70 of common ſalt, but the Glauber's ſalt at leaſt did not exiſt in a cryſtallized form in the barilha; and as 100 grains of it are reduced to 42 by expelling the water of cryſtallization, no more than 53 grains of it can be deemed to have pre-exiſted in the barilha.

THESE ſolutions alſo depoſited 20 grains of earth.

HENCE the weights of the different ingredients contained in one pound of ſweet barilha are as follows:

Fixed air	960	
Charcoal	861,82	
Calcareous earth	542,86	1050,67
Muriatic earth	127	
Argillaceous	131,23	
Siliceous	249,58	
Mineral alkali pure	842	1219
Mineral ditto impure	250	
Mineral ditto mixed with common ſalt	127	
Glauber's ſalt	125	
Common ſalt	70	
Earth depoſited	20	
	4306,49	
Water	1453,51	
Total	5760,00	

Hence we ſee that the alkaline part of barilha is nearly in a cauſtic ſtate, for the intire pound of barilha contained but 960 grains of fixed air, and of this quantity we have ſeen that 759 were contained in the earthy part. Therefore only 201 grains were contained in the ſaline part. Now 960 grains of this (and the mere alkaline part did not certainly amount to leſs) require for their ſaturation at leaſt 700 of fixed air, therefore they wanted at leaſt $\frac{2}{3}$ of the quantity requiſite to ſaturate them. And hence bleachers ſhould not uſe boiling water to extract the ſaline ſubſtance of barilha, for the alkaline part being in a cauſtic ſtate diſſolves part of the coaly matter with which it is united, which ſullies the ſolution, gives it a dark hue, and afterwards is depoſited on the linen, and cannot be ſeparated by acids.

SECTION III.

OF DANTZIC PEARL ASH.

THIS ſalt was alſo ſent to me by Mr. Byrne. It is exceeding white, and if not expoſed to the air, very hard, and poſſeſſes an alkaline taſte.

THE quantity of fixed air and earth contained in different parcels of this ſubſtance is variable; in ſome ounces I found the quantity of fixed air to amount to 100 grains, in others to 115; and therefore at a medium it may be rated at 107,5 grains, or 1290 grains, in one pound troy. The earth remaining after the ſolution of one pound amounted to 20 grains.

ONE ounce of this ſubſtance gradually heated to redneſs, and kept in that heat for three quarters of an hour, loſt 70 grains of its weight; and being then diſſolved in ſpirit of ſalt, loſt 72 grains; therefore the quantity of moiſture in one ounce of this ſubſtance was $70-\overline{107,5-72}=34,5$ grains, or 414 in one pound.

Again, after ten evaporations I procured from one pound of this ſubſtance 505 grains of tartar vitriolate, the laſt portions of which appeared by the teſt of the nitrous ſolution of ſilver to contain ſome digeſtive ſalt, and alſo 36 grains of this laſt containing a portion of tartar vitriolate; about 18 grains of earth were depoſited during the evaporations. The remainder of the pound, after all theſe deductions, muſt have conſiſted of pure mere alkali. Hence the ingredients in a pound muſt have been nearly in the following quantities:

Fixed air - -	1290	
Moiſture - -	414	
Tartar vitriolate - -	505	
Digeſtive ſalt and ditto -	36	
Earth - - -	38	
	2283	5760
Mere alkali - -	3477	—2283
	5760	3477

Disgusted by the tedioufneſs of theſe experiments, and recollecting that the alkaline part of theſe ſalts was that alone with which bleachers had any concern, I bethought myſelf of an eaſy practical method of diſcovering the preſence of this principle, and determining its quantity in all ſubſtances in which it exiſts, either uncombined, or combined only with fixed air or ſulphur.

SECTION IV.

To diſcover whether any quantity of fixed alkali worth attention exiſts in any ſaline compound, diſſolve one ounce of it in boiling water, and into this ſolution let fall a drop of a ſolution of ſublimate corroſive; this will be converted into a brick colour, if an alkali be preſent, or into a brick colour mixed with yellow, if the ſubſtance tried contains lime.

But the ſubſtances uſed by bleachers being always impregnated with an alkali the above trial is in general ſuperfluous, except for the purpoſe of detecting lime. The quantity of alkali is therefore what they ſhould chiefly be ſolicitous to determine, and for this purpoſe:

1ſt, Procure a quantity of allum, ſuppoſe one pound, reduce it to powder, waſh it with cold water, and then put it into a tea-pot, pour on it three or four times its weight of boiling water.

2dly, Weigh an ounce of the aſh or alkaline ſubſtance to be tried, powder it and put it into a Florence flaſk with one pound of pure water, (common water boiled for a quarter of an hour, and afterwards filtered through paper, will anſwer) if the ſubſtance to be examined be of the nature of barilha or pot-aſh; or half a pound of water if it contain but little earthy matter, as pearl-aſh; let them boil for a quarter of an hour, when cool let the ſolution be filtered into another Florence flaſk.

3dly, This being done, gradually pour the ſolution of allum hot into the alkaline ſolution alſo heated; a precipitation will immediately appear; ſhake them well together, and let the effervеſcence, if any, ceaſe before more of the aluminous ſolution be added; continue the addition of the allum until the mixed liquor, when clear, turns ſyrup of violets or paper tinged blue by raddiſhes, or by litmus, red; then pour the liquor and precipitate on a paper filter placed in a glaſs funnel, the precipitated earth will remain on the filter; pour on this a pound or more of hot water gradually until it paſſes taſteleſs; take up the filter and let the earth dry in it until they ſeparate eaſily, then put the earth into a cup of Staffordſhire ware, place it on hot ſand and dry the earth until it ceaſes to ſtick to glaſs or iron, then pound it and reduce it to powder in the cup with a glaſs peſtle, and keep it a quarter of an hour in a heat of from 470° to 500°.

4thly, The earth being thus dried, throw it into a Florence flaſk and weigh it, then put about one ounce of ſpirit of ſalt into another flaſk, and place this in the ſame ſcale as the earth, and counterbalance both in the oppoſite ſcale: This being done, pour the ſpirit of ſalt gradually into the flaſk that contains the earth, and when all effervеſcence is over, (if there be any) blow into the flaſk, and obſerve what weight muſt be added to the ſcale containing the flaſks to reſtore the equilibrium; ſubtract this weight from that of the earth, the remainder is a weight exactly *proportioned* to the weight of mere alkali of that particular ſpecies which is contained in one ounce of the ſubſtance examined; all beſide is ſuperfluous matter.

I HAVE ſaid that alkalies of the *ſame ſpecies* may thus be directly compared, becauſe alkalies of *different* ſpecies cannot, but require the intervention of another proportion; and the reaſon is, becauſe *equal* quantities of alkalies of different ſpecies precipitate *unequal* quantities of earth of allum. Thus 100 parts by weight of mere *vegetable* alkali precipitate 78 of earth of allum; but 100 parts of *mineral* alkali precipitate 170,8 parts of that earth. Therefore the precipitation of 78 parts of earth of allum by vegetable alkali denotes as much of this, as the precipitation of 170,8 of that earth by the mineral alkali, denotes of the mineral alkali. Hence the quantities of alkali in all the different ſpecies of pot aſhes, pearl aſhes, weed or wood aſhes, may be immediately compared by the above teſt, as they all contain the vegetable alkali, and the different kinds of kelp or kelps manufactured in different places, and the different ſorts of barilha, may thus be compared, becauſe they all contain the mineral alkali; but kelps and pot aſhes, as they contain different ſorts of alkali, can only be compared together by means of the proportion above indicated.

THE application of this teſt is founded on the following principles:

1ſt, That a hot ſolution of a free alkali, or of an alkali combined only with fixed air or ſulphur, can hold no *terreno* or *metallico neutral* ſalt in ſolution; though it may *alkalino neutral* ſalts or quick lime, if the alkali be free from fixed air.

2dly, That earth of allum cannot be precipitated either totally or partially by the hot ſolutions of any *alkalino neutral* ſalt, and therefore that its precipitation is always due to the preſence of a free alkali, or at leaſt of an alkali combined only with fixed air or ſulphur, to whoſe quantity it is always proportional. It is true quick lime will alſo decompoſe allum, but the preſence of quick lime is eaſily diſcovered by the addition of a few drops of any mild alkaline ſolution, and by the ſame means as eaſily ſeparated.

3dly, That if the earth of allum takes up fixed air, (which would increaſe its weight) this air will be ſeparated by the heat employed in drying it, or at leaſt by the ſpirit of ſalt poured upon it, and ſo may alſo another heterogeneity which will hereafter be mentioned.

I CAN ſee but one inaccuracy attending this teſt, and that of little moment; it is this, if the alkali contains ſulphur, this will alſo be precipitated with the earth of allum and increaſe its weight. The limits of this inaccuracy, at leaſt in common caſes, ſcarcely reach 2 or 3 grains, as we ſhall preſently find.

SULPHUR is eaſily detected in any alkaline ſolution by ſaturating it with an acid; hepatic air is generally developed, and the liquor becomes troubled.

NOT only the proportion but alſo the *abſolute* weight of alkali in different alkaline ſubſtances or aſhes may be found by this teſt, as will appear by the following experiments:

SECTION V.

Of the Quantity of mere Alkali in different Alkaline Subſtances as exhibited by the aluminous Teſt.

CRYSTALLIZED SODA.

I BEGIN with this as being the pureſt mineral alkaline ſubſtance in a dry form produced by art. Though it contains only $\frac{1}{5}$ of its weight of real alkali, the remainder being water and fixed air, but the proportion of alkali being invariably the ſame, it is the fitteſt for a ſtandard with which other ſubſtances containing the ſame ſort of alkali may be compared. I found that as much of this ſubſtance as would contain 480 grains of mere alkali would precipitate 725 grains of earth of allum dried and treated as already mentioned, and conſequently that 480 grains of *mere* mineral alkali precipitate 725 of earth of allum.

NOTE, That in this and all the ſubſequent experiments a little more earth of allum is precipitated than is mentioned, becauſe a little always remains in the filtering paper that cannot be had out of it, and I have reaſon to think by weighing the paper before and after, that this quantity amounts to 3 or 4 grains; but as this defect is the ſame in all caſes, it does not invalidate the compariſon.

SWEET BARILHA.

THE ſolution of one ounce of barilha precipitated 174 grains of earth of allum; therefore, ſince 725 grains of earth of allum require for their precipitation 480 of mere mineral alkali, 174 grains of that earth require 115,2 of mere mineral alkali. And conſequently one ounce of barilha contains but 115,2 of mere alkali; and one pound of barilha ſhould contain 1382,4 grains. This quantity exceeds by about $\frac{1}{8}$ the quantity I found by direct analyſis, but poſſibly one pound may contain more than another, for it could ſcarcely happen that I ſhould commit a miſtake of that magnitude.

I MUST not here omit an odd appearance that occurred in this experiment: The earth of allum in drying acquired a bluiſh colour, and when ſpirit of ſalt was poured on it, to diſengage the fixed air it might contain, the blue colour was more developed, and ſome blue particles floated in the liquor. This ſeems to proceed from the tinging matter of Pruſſian blue which has been found in barilha. The weight of this I have not examined, but it could not exceed 1 or 2 grains.

CUNNAMARA KELP.

THIS was manufactured by Mr. Martin Mealy, and ſent to me by Mr. Francis French, an eminent merchant in this city. It is a hard porous black ſubſtance, mixed with white and grey ſpots, its ſmell ſulphureous, and its taſte mixed, being that of common ſalt and alkali. One ounce of it diſſolved in marine acid loſt 24 grains of its weight, which eſcaped in an aerial form. This air was hepatic.

Another ounce diſſolved in boiling water left an inſoluble reſidue, which being heated in a crucible to redneſs weighed 165 grains; this reſidue effervefced with acids, and ſeemed for the moſt part calcareous.

The ſolution by the teſt of the nitrous ſolution of ſilver evidently contained ſulphur, and the Pruſſian alkali gave manifeſt ſigns of iron.

This ſolution precipitated 25 grains of earth of allum, and therefore contained 16,5 grains of mere alkali. During the precipitation of the earth of allum much hepatic air was emitted, and the earth was ſullied by the ſulphur, though only a few grains of this can be preſumed to be mixed with it.

To find the quantity of ſulphur in this kelp I diſſolved two ounces of it in pure water, and ſaturated the ſolution with marine acid; the liquor became turbid, and partly by filtration and part by ſpontaneous depoſition, (for ſome of the ſulphur paſſed through the filter) I obtained 8 grains of ſulphur, which gives 4 grains for each ounce, beſides what exhaled in hepatic air.

In order to eſtimate the quantity of ſulphur which a given quantity of mineral alkali is capable of containing, I diſſolved 400 grains of cryſtallized mineral alkali in ſix times its weight of water, (this quantity of the cryſtals contained 80 grains of mere alkali) and to this I added 80 grains of ſulphur, and boiled them for half an hour; only 60 grains of ſulphur were diſſolved, by which I found that this alkali can take up nearly $\frac{3}{4}$ of its weight of ſulphur in the moiſt way; I ſay nearly, as ſome earth remained with the undiſſolved ſulphur. With this ſaturated liver of ſulphur I precipitated a ſolution of allum, and found the precipitate to amount to 130 grains. Now 80 grains of mere mineral alkali can precipitate only 120,8 grains of earth of allum; therefore 9 grains of the above precipitate were ſulphur. Yet this ſmall proportion of ſulphur was very viſible in the earth of allum when heated to 500 degrees, by its ſtrong yellow colour; therefore in the precipitation of the earth of allum by kelp, in which no ſulphur was viſible, the proportion was incomparably ſmaller, and no deduction need be made on that account.

THERE are three methods of deſulphurating kelp, or any other alkalino ſulphureous compound: The firſt is by calcining it in an open fire by expoſing it to a rapid blaſt of air; and for this a very ingenious contrivance was deviſed by my much reſpected friend Mr. WILLIAM DEAN. The only inconvenience attending it is that much of the ſulphur will be converted into vitriolic acid, and thus combine with the alkali. The ſecond is by ſaturating it with a vegetable acid, and afterwards calcining it, by which means the vegetable acid will be decompoſed; if this method could be cheaply executed it would be the beſt. The third is by ſaturating a ſolution of kelp with fixed air: This I have endeavoured to effect by putting a ſolution of two ounces of kelp into Doctor Nooth's machine for impregnating water with fixed air; the liquor ſoon became turbid, and emitted a ſtrong hepatic ſmell; after the ſulphur had ſubſided I drew off the liquor, and with one half of it precipitated a ſolution of allum. No hepatic ſmell was now perceptible, and the precipitate amounted to 40 grains. I dare not ſay that this great increaſe of power in the alkali was intirely owing to the deſulphuration, but ſome part undoubtedly was; yet the quantity of ſulphur I could collect was very inconſiderable, and mixed with coal duſt. Kelp may alſo be deſulphurated by nitre, as ſhall hereafter be ſhewn. According to Doctor Watſon, 30 ounces of kelp afforded him 12 ounces of cryſtallized mineral alkali, conſequently 1 ounce would afford ,4 of an ounce, that is 192 grains, of which $\frac{1}{5}$, that is =38 grains, muſt have been mere alkali. His kelp might have been better than that I uſed; but it is impoſſible that his alkali was pure, as mineral alkali, when mixed with ſuch a quantity of common ſalt as is in kelp, can never be thoroughly ſeparated from it, but by proceſſes which he certainly did not uſe, namely, by precipitating a ſolution of ſilver in ſpirit of nitre, eſtimating the quantity of luna cornua, and afterwards decompoſing the cubic nitre, or by ſaturating the alkali with diſtilled vinegar, and diſſolving the neutral ſalt thus formed in ſpirit of wine, which leaves the common ſalt behind.

STRANGFORD KELP.

THIS was ſent to me by my worthy friend Mr. BRAUGHALL. It was much denſer, leſs porous, and in appearance approached more to that of a vitrified maſs than Cunnamara kelp; it was at leaſt equally ſulphureous. The ſolution of one ounce of it precipitated only 9 grains of earth of allum, and this earth was much more diſcoloured than that precipitated by Cunnamara kelp. The inſoluble reſiduum of an ounce amounted to 174 grains.

VEGETABLE ALKALI.

I FOUND that 480 grains of the pureſt and drieſt ſalt of tartar (making allowance for the quantity of fixed air it contained) precipitated 331,5 grains of earth of allum.

DANTZIC PEARL ASH.

THE ſolution of one ounce of this ſalt precipitated in one experiment 200 grains of earth of allum; and in another 220 grains; at a medium 210 grains. Then if 331,5 grains of this precipitate require 480 grains of mere vegetable alkali, 210 grains of this precipitate require 304; therefore at a medium an ounce of this ſubſtance contains 304 grains of mere alkali, and a pound contains 3648. By my analyſis it contained 3477 grains; the difference is 171 grains.

WE may now determine which of two or more ſaline ſubſtances, one poſſeſſing the mineral, the other the vegetable alkali, is beſt in its kind; for that ſubſtance is beſt in its kind which approaches moſt to its proper ſtandard; 725, that is, the precipitation of 725 grains of allum being the ſtandard of the goodneſs of an ounce of a ſubſtance containing the mineral alkali, and 331,5 being the ſtandard of the richneſs of an ounce of a ſubſtance containing the vegetable alkali. Thus, if we compare barilha and Dantzic pearl aſh, as the ſtandard of barilha is to the quantity of earth of allum, an ounce of it precipitates, ſo is the ſtandard of Dantzic to the quantity an ounce of it precipitates; or 725 : 174 : : 331,5 : 79,5, by which we ſee that an ounce of Dantzic ſalt that would precipitate 79,5 grains of earth of allum would be as good in its kind as an ounce of barilha that precipitates 174; therefore ſince an ounce of Dantzic ſalt precipitates 210, it is richer in its kind by the difference between 79,5 and 210.

WITH reſpect to antacid powers the mineral alkali is ſtronger than an equal quantity of the vegetable, that is, will ſaturate more acid, nearly in the proportion of 48 to 22; yet it attracts acids leſs, that is, with leſs force and activity, ſince the vegetable will take them from the mineral alkali. But if the quantities of real alkali be unequal we may compare their antacid powers in this manner: As the precipitate by an ounce of a ſubſtance containing the mineral alkali is to 48, ſo is the precipitate by an ounce of a ſubſtance containing the vegetable alkali to a number expreſſing its comparative antacid power. Thus with reſpect to barilha and Dantzic ſalt, as 174 : 48 : : 210 : 58 nearly; therefore the antacid power of Dantzic ſalt is greater than that of barilha, when taken in equal quantities in the ratio of 58 to 48.

CASHUP.

THE beſt ſort, namely, that marked with the croſs arrows, is of a bluiſh grey colour, exceeding hard and of a ſemivitrified appearance, its ſmell ſulphureous, its taſte ſcarcely alkaline, and does not attract the moiſture of the air. With marine acid, one ounce of it afforded 31 grains of hepatic air. When diſſolved in water the reſiduum of an ounce was 357 grains of a grey earth that appeared to be calcareous for the moſt part. The ſolution itſelf was of a yellow colour and ſtrongly ſulphureous. With the ſolution of allum it did not effervеſce ſtrongly until a good deal was added. The precipitate was of a dirty white, and amounted to 66 grains, of which two appeared to be ſulphur. Hence its quantity of vegetable alkali is nearly 93 grains per ounce.

MR. CLARKE'S REFINED ASH.

THIS I obtained from Mr. CLARKE himſelf. It is of a yellowiſh white colour, with greeniſh ſpots; many pieces are externally white and internally green; it is moderately hard, of a very ſharp taſte, and effervеſces with acids.

AN ounce of this ſubſtance diſſolved in twelve ounces of boiling water did not effervеſce with acids, but precipitated the ſolution of ſublimate corroſive yellow and red as lime water does, and left a reſiduum of 17 grains, which was evidently calcareous. A ſolution of two ounces of this ſubſtance being impregnated with fixed air in Doctor NOOTH's machine, depoſited 5 grains of mild calcareous earth; but a ſolution made in three or four times its weight of water, or without the aſſiſtance of heat, contained no lime, and effervеſced ſlightly with acids; and when this ſalt is ſome time expoſed to the air, its ſolution contains no lime.

A SOLUTION of one ounce of this ſalt precipitated 89 grains of earth of allum, and therefore contained 129 grains of mere vegetable alkali, to which if we add 17 grains of inſoluble earth, we ſhall find that the remainder of the ounce, namely, 334 grains, conſiſted of neutral ſalts, namely, digeſtive ſalt, and perhaps tartar vitriolate, in ſmall quantity. To prove the exiſtence of theſe I ſaturated an ounce of the ſolution of this refined aſh with the nitrous acid, and then dropped into it the nitrous ſolution of ſilver; this latter was immediately precipitated in a curdy form, which as the alkaline part was ſaturated could proceed only from the marine acid contained in the digeſtive ſalt.

In the report of the committee of the houſe of commons, dated April 1788, Mr. Clarke delivers an account of his method of manufacturing this ſalt. He mixes five parts weed or wood aſhes with one part quick lime, and ſuffers them to lie together in a heap for ſix, nine or twelve months, and then extracts a ley from them which he evaporates to dryneſs. By ſuffering the lime and aſhes to ſtand together for ſo many months, he imagines that the common ſalt contained in the aſhes is decompoſed, and the quantity of alkali thus increaſed; but though it is poſſible to decompoſe common ſalt by quick lime, as Mr. Scheele has ſhewn, yet this decompoſition is effected by a very different management; and if in the firſt part of Mr. Clarke's proceſs ſuch a decompoſition were obtained, a recompoſition would ſpeedily be effected in the ſecond part of his proceſs; for ſuppoſing the marine acid to quit its alkaline baſis and unite to the lime, yet when the alkaline ſalt and marine ſelenite are both drawn off into the ley, the alkali immediately decompoſes the marine ſelenite and reunites to its acid, according to the well

known

known laws of chymical affinity. So that by this long *maceration* (as he calls it) no advantage whatſoever is gained. However, Mr. CLARKE's ſalt is undoubtedly a valuable preparation for the purpoſe of bleaching, and may be obtained in a ſpace of time incomparably ſhorter than he requires.

THE neutral ſalts contained in the ſolution of Mr. CLARKE's refined aſh do not proceed from any error in his proceſs, but from the bad quality of the aſhes he employs.

COMMON IRISH WEED ASHES.

I OBTAINED a parcel of theſe aſhes from Mr. CLARKE; it was of a looſe texture, dark grey colour and ſalt taſte, mixed with charcoal, brick duſt and other impurities. I choſe the cleaneſt, and ſifted it. One ounce of it loſt by gentle drying 47 grains, and in a red heat 72 grains more.

TWELVE ounces of the undried aſhes being lixiviated, left a reſiduum, which when dried weighed 4214 grains; the ſolution was reddiſh, replete with extractive matter; it afforded a large quantity of digeſtive ſalt, and ſome tartar vitriolate, and very little alkali.

TWO ounces of the ſame aſhes being gently heated to a ſlight degree of redneſs loſt 186 grains of their weight. One ounce of this calcined aſh being boiled in ſix ounces of water left a reſiduum of 344 grains, and conſequently contained 136 grains of ſaline matter; but of this ſaline matter only 22,4 grains were pure alkali, for the ſolution precipitated only 15,5 grains of earth of allum; an hepatic ſmell was perceived during the precipitation of the allum, and the earth was of a dirty colour.

I TRIED alſo another ſort of aſhes which I had from a chandler; it was of a whiter colour and cleaner. The ſolution of an ounce of it in ſix ounces of water precipitated only 5,5 grains of earth of allum, and therefore contained but 8 grains of mere alkali.

THERE is a remarkable circumſtance attending theſe aſhes, namely, that if they be much calcined they ſeem to loſe their alkaline properties, and the ſolution no longer precipitates that of ſublimate corroſive reddiſh, as alkalies not thoroughly aerated do. What this circumſtance depends on I have not as yet examined, but am almoſt certain it proceeds from the preſence of common ſalt, as fixed alkalies and common ſalt melt very eaſily, and thus unite to the earths.

To eſtimate the goodneſs of different aſhes, ſome have recommended the uſe of an hydrometer, whereby to diſcover the ſtrength of ſolutions of equal weights of theſe aſhes in equal quantities of water; but as this inſtrument is equally affected by the preſence of neutral ſalts, as of alkali, it becomes uſeleſs.

Table of the Quantity of mere Alkali in one hundred Avoirdupois Pounds of the following Subſtances by the aluminous Teſt:

One hundred pounds,	Mineral Alkali.
Cryſtallized ſoda - - -	20 lbs.
Sweet Barilha - - - -	24
Mealy's Cunnamara kelp - -	3,437
Ditto deſulphurated by fixed air - -	4,457
Strangford kelp - - -	1,25

One hundred pounds,	Vegetable Alkali.
Dantzic pearl aſh - - -	63,33 lbs.
Clarke's refined aſh - - -	26,875
Caſhup - - - -	19,376
Common raw Iriſh weed aſh - -	1,666
Ditto ſlightly calcined - - -	4,666

SECTION VI.

Of the beſt Manner of procuring Alkaline Salts.

1ſt, OF THE METHOD OF PROCURING MINERAL ALKALI.

MINERAL ALKALI may be procured more or leſs pure from the combuſtion of the various ſpecies of kali or ſalſola of Linneus, or from that of the different ſpecies of ſalicornia and chænopodia, mentioned by the ſame author. The compounds thus formed are called *barilhas* or *ſoudes*.

THE cultivation of the ſalicornia may be ſeen in the fifth volume of the *Memoires des Scavants Etrangers*. A French acre (1,261 Engliſh) produces one tun of this weed; and this tun when burned produces but 100 weight of barilha, and this of a kind inferior to ſweet barilha. A ſmall quantity of this alkali is alſo contained in kelp. I am inclined to think that much of the alkali is loſt by its union with the earthy parts during the fuſion effected in the common manner of fabricating this ſubſtance; and therefore the proceſs ſuggeſted by Mr. CADET may be uſeful. He adviſes a trench two feet deep, ſeven feet long, and eighteen inches broad, to be made, lined with clay mixed with ſand, and over this iron bars two inches diſtant from each other to be laid; upon which a wall 2,5 feet high is to be conſtructed, of limeſtone if poſſible; over the bars the dry ſea weed is to be laid and ſet fire to; the aſhes will fall into the trench, and when it is full the fire is diſcontinued *. I believe alſo that waſhing the ſea weed in freſh water, to carry off the ſea ſalt that adheres to it, would be uſeful.

To deſulphurate kelp, Abbé MAZEAS recommends projecting on it while in a red heat $\frac{1}{3}$ of its weight of nitre; but this proceſs ſeems too expenſive to be practiſed in the great.

2dly, This alkali is found native in Ægypt and ſeveral parts of the Ruſſian empire, and perhaps may be cheaply imported.

3dly, Common ſalt may be decompoſed after Mr. TURNER's method, by trituration with litharge, as the calx of lead here employed is afterwards converted into a yellow pigment. This method is very beneficial.

I HAVE alſo contrived another proceſs for decompoſing common ſalt. The particulars of my experiment were as follows:

1ſt, I rendered the common ſalt pure by adding to its ſolution a ſolution of mineral alkali until all the earthy matter was depoſited.

2dly, To a ſolution of three ounces of this purified ſalt in nine ounces of water I gradually added a ſaturate ſolution of 4,75 ounces of ſugar of lead, both hot, until the ſolution of lead ſcarce excited any whiteneſs in that of the common ſalt. After one

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* Mem. Paris, 1767.

one night's reſt part of the ſugar of lead cryſtallized in the bottom of the veſſel, by which it is plain that too much of it had been uſed. Theſe cryſtals weighed 240 grains; the ſupernatent liquor I again evaporated to nearly $\frac{2}{3}$, and after two days obtained large pellicles of acetous ſoda, which I ſeparated; they weighed 325 grains; to the reſiduum, which ſtill had a ſweetiſh taſte, I added a ſolution of mineral alkali, until no further precipitation appeared; a very ſmall quantity of the alkali was ſufficient for this purpoſe. I then evaporated the remainder nearly to dryneſs; and afterwards heated it in a crucible to redneſs: In this heat it inflamed, and when calcined nearly to whiteneſs, I took it out and diſſolved it in twelve ounces of water, filtered it, and on adding an hot ſolution of allum obtained a precipitate, which when dried weighed 169 grains, and indicated the quantity of pure alkali to be 112 grains nearly. In this proceſs nothing is loſt, for the lead may be either revived or turned into a pigment.

Laſtly, Glauber's ſalt may afford the mineral alkali, but moſt eaſily in the form of liver of ſulphur: I endeavoured to decompoſe it by the above proceſs, but the quantity of alkali obtained from a large quantity of it was very inconſiderable.

OF THE VEGETABLE ALKALI.

IT is univerſally known that this alkali may be extracted in greater or leſſer quantity, by lixiviation, from the aſhes of almoſt all vegetables, and it is *now* well eſtabliſhed that it preexiſts in vegetables before combuſtion; not indeed in a ſeparate uncombined ſtate, but united partly with the vitriolic or marine acids, and ſometimes the nitrous, but generally and for the greater part with a vegetable acid or oil, with which it forms eſſential ſalts, as they are termed. Theſe vegetable acids and oils are decompoſed during combuſtion, and thus the alkaline part is ſet free; but the vitriolic by contact with inflamed matter is converted into ſulphur, part of which unites to the free alkali, which protects it from combuſtion, and thus forms what is called *liver of ſulphur*, a product found in moſt aſhes, eſpecially when the air has not had free acceſs to them during combuſtion.

As alkaline ſalts are of great importance in ſeveral arts, the proportion of aſhes afforded by different vegetables, and that of alkali by the aſhes of each ſort of vegetable, has of late been accurately attended to, I ſhall here preſent the beſt authenticated reſults of the experiments made with this view.

One thouſand weight of the following vegetables, perfectly dry and burned in a clean chimney and open fire, afforded the quantity of aſhes and ſaline matter, exhibited in the annexed table:

One thouſand pounds.	Pounds of Aſhes.	Pounds of Salt.	
Stalks of Turkey wheat or mais	88,6	17,5	
Of Sun-flower	57,2	20	
Vine branches	34	5,5	
Box	29	2,26	
Sally	28	2,85	
Elm	23,5	3,9	
Oak	13,5	1,5	
Aſpin	12,2	0,74	
Beech	5,8	1,27	
Fir	3,4	0,45	
Fern in Auguſt	36,46	4,25	Home.
Wormwood	97,44	73	Wiegleb.
Fumitary	219	79	Id.

Table of the ſaline Product of one thouſand Pounds of Aſhes of the following Vegetables.

	Saline products.	
Stalks of Turkey wheat or mais	198 lbs.	
Ditto of Turnſel or Sun-flower	349	
Vine branches	162,6	
Elm	166	
Box	78	
Sally	102	
Oak	111	
Aſpin	61	
Beech	219	
Fir	132	
Fern cut in Auguſt	116, or 125	according to Wildenheim.
Wormwood	748	
Fumitary	360	
Heath	115	Wildenheim.

HENCE we ſee that in general weeds yield much more aſhes, and their aſhes much more ſalt, than woods; and that conſequently as to ſalts of the vegetable alkali kind, as pot aſh, pearl aſh, caſhup, &c. neither America, Trieſte, or the Northern countries, poſſeſs any advantage over us.

2dly, That of all weeds fumitary produces moſt ſalt, and next to it wormwood; but if we attend only to the quantity of ſalt in a given weight of aſhes, the aſhes of wormwood contain moſt. *Trifolium fibrinum* alſo produces more aſhes and ſalt than fern.

MOST of the experiments on woods were made in France by order of government, under the inſpection of the overſeers of the ſalt-petre works; yet are to be read with caution by thoſe that attend to the quantity of alkali with reſpect to bleachers; for as tartar vitriolate (a ſalt uſeleſs to bleachers) is as ſerviceable to the makers of ſalt-petre as alkaline ſalts, they have conſtantly confounded one with the other; but the experiments made on weeds were inſtituted by perſons who carefully diſcriminated theſe ſalts: 100 grains of the ſalt of wormwood contain but ſix of tartar vitriolate, and 100 grains of the ſalt of fumitary contain 15. All alkaline ſalts, unleſs mixed with lime, contain alſo $\frac{1}{5}$ at leaſt of fixed air, which produces no other effect in bleaching than that of reſtraining their activity.

SECTION VII.

Of the Proceſs for obtaining pot and pearl Aſh.

1ſt, The weeds ſhould be cut juſt before they ſeed, then ſpread, well dried, and gathered clean.

2dly, They ſhould be burned within doors on a grate, and the aſhes laid in a cheſt as faſt as they are produced. If any charcoal be viſible it ſhould be picked out and thrown back into the fire. If the weeds are moiſt much coal will be found. A cloſe ſmothered fire, which has been recommended by ſome, is very prejudicial.

3dly, They ſhould be lixiviated with twelve times their weight of boiling water. A drop of the ſolution of ſublimate corroſive will immediately diſcover when the water ceaſes to take up any more alkali. The earthy matter that remains is ſaid to be a good manure for clayey grounds.

4thly, The ley thus formed ſhould be evaporated to dryneſs in iron pans; two or three at leaſt of theſe ſhould be uſed, and the ley as faſt as it is concentrated paſſed from one to the other; thus much time is ſaved, as weak leys evaporate more quickly than the ſtronger. The ſalt thus procured is of a dark colour, and contains much extractive matter, and being formed in iron pots is called *pot aſh.*

5thly, This ſalt ſhould then be carried to a reverberatory furnace, in which the extractive matter is burned off and much of the water diſſipated; hence it generally loſes from 10 to 15 per cent. of its weight. Particular care ſhould be taken that it ſhould not melt, as the extractive matter would not be thoroughly conſumed, and the alkali would form ſuch a union with the earthy parts as could not eaſily be diſſolved. I added this caution, as Doctor LEWIS and Mr. DOSSIE have inadvertently directed the contrary. This ſalt thus refined is called pearl aſh, and muſt be the ſame as Dantzic pearl aſh *.

FOR the moſt œconomical conſtruction of a laboratory and furnaces for the above operations I refer to the deſcription given in a French tract, called *l'art de fabriquer le ſalin & la potaſſe*; and ſhall only add, that if the ſalt were extracted by a fire ſupported by vegetables whoſe aſhes might afterwards be employed, no inconſiderable advantage would be gained. Pearl aſh is frequently tinged green or blue; this colour it acquires during fuſion, not from any union of the ſalt with phlogiſton, as was formerly ſuppoſed, but by reaſon of the mangancſe contained in the aſhes of almoſt all vegetables, as Mr. SCHEELE has ſhewn. When it is calcined without melting it is perfectly white as Dantzic pearl aſh.

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* The French call the refined aſh *pot aſh*, and the unrefined *ſalin*.

SECTION VIII.

Of the Colouring Matter of Linen Yarn and its Solvents.

HAVING, through the obliging attention of Mr. ARBUTHNOT, procured a ſufficient quantity of alkaline ley ſaturated with this colouring matter, or, as the workmen call it, *killed*, and which they are in the habit of throwing away; I found it to be a turbid liquor, of a reddiſh brown colour, a peculiar taſte and ſtrong ſmell, affording no ſign either of acidity or alkaleſcence. On five quarts of this liquor I poured two ounces of weak marine acid; there was no efferveſcence, but a copious depoſition inſtantly took place of a greyiſh green colour, and the liquor freed from this depoſit was of the colour of red amber.

THE next day I drew off the liquor with a ſyphon, and poured two quarts of pure water on the depoſited matter, and having agitated the whole, ſuffered this matter again to ſubſide, drew off the water, and added two quarts more; this liquor gave manifeſt ſigns of acidity, and continued ſomewhat reddiſh. Preſuming that after the addition of ſo much water this acidity could not proceed from the ſmall quantity of marine acid I had uſed, more eſpecially as the liquor originally contained an alkali, in the ſaturation of which the greater part of the acid muſt have been employed, I began to ſuſpect that this ley contained an acid of its own, which was diſengaged and ſeparated from the alkali by the marine acid as the more powerful of the two; and hence I reſerved the two quarts of liquor, laſt added, for ſubſequent experiments.

After repeated affuſions of cold water, when the characters of acidity were ſcarcely any longer perceptible, I threw the depoſited matter on a filter and ſuffered it to dry for ſome time; it was then of a dark greeniſh colour, ſomewhat clammy like moiſt clay. I took a ſmall portion of it and added to it ſixty times its weight of boiling water, but not a particle of it was diſſolved. The remainder I dried in a ſand heat; it then aſſumed a ſhining black colour, became more brittle, but internally remained of a greeniſh yellow, and weighed 1½ ounce.

By treating eight quarts more of the ſaturated ley in the ſame manner, I obtained a further quantity of the greeniſh depoſit, on which I made the following experiments:

1ſt, Having digeſted a portion of it in rectified ſpirit of wine, it communicated to it a reddiſh hue, and was in great meaſure diſſolved; but by the affuſion of diſtilled water the ſolution became milky, and a white depoſit was gradually formed; the black matter diſſolved in the ſame manner.

2dly, Neither the green nor the black matter was ſoluble in oil of turpentine or linſeed oil by a long continued digeſtion.

3dly, The black matter being placed on a red hot iron, burned with a yellow flame and a black ſmoke, leaving a coaly reſiduum.

4thly, The green matter being put into the vitriolic marine and nitrous acids communicated a browniſh tinge to the two former, and a greeniſh to the latter, but did not ſeem in the leaſt diminiſhed.

HENCE it appears that the matter extracted by alkalies from linen yarn is a peculiar ſort of *reſin*, different from pure reſins only by its inſolubility in eſſential oils, and in this reſpect reſembling lacks. I now proceeded to examine the power of the different alkalies on this ſubſtance: 8 grains of it being digeſted in a ſolution of cryſtallized mineral alkali ſaturated in the temperature of 60°, inſtantly communicated to the ſolution a dark brown colour; two meaſures (each of which would contain eleven penny weights of water) did not intirely diſſolve this ſubſtance. Two meaſures of the mild vegetable alkali diſſolved the whole.

ONE meaſure of cauſtic mineral alkali, whoſe ſpecific gravity was 1,053, diſſolved nearly the whole, leaving only a white reſiduum.

ONE meaſure of cauſtic vegetable alkali, whoſe ſpecific gravity was 1,039, diſſolved the whole.

ONE meaſure of liver of ſulphur, whoſe ſpecific gravity was 1,170, diſſolved the whole.

ONE meaſure of cauſtic volatile alkali diſſolved alſo a portion of this matter.

THOUGH theſe experiments were fully ſufficient to reſolve my own doubts, yet to render ſtill more ſatisfaction to bleachers, I repeated them with the ſalts they generally uſe, and alſo with ſoap.

I THEREFORE diſſolved one ounce of ſweet barilha, Dantzic pearl aſh, Cunnamara kelp, caſſup and CLARKE's pearl aſh, each in ſix ounces of pure water, and putting in one ounce meaſure of each ſolution, 8 grains of the green colouring matter, ſet them to digeſt in a heat of about 180° for 3½ hours. At the end of this time I found that

The Dantzic diſſolved more than the barilha.

The kelp as much as the Dantzic.

The caſhup and CLARKE's diſſolved the whole.

HENCE I added half an ounce more of the ſolutions of Dantzic, barilha and kelp; the Dantzic and kelp then diſſolved the whole, but of the ſolution of barilha two ounces were requiſite to perform this effect.

I ALSO diſſolved half an ounce of Windſor ſoap in eighteen ounces of water; the ſolution was turbid, and could not be rendered tranſparent but when it was near boiling, and then it was very unmanageable, for when boiled it ſpouted three feet high out of the bottle. Three ounces of this ſolution were requiſite to diſſolve 8 grains of the colouring matter.

Now to compare the powers of theſe different ſolvents we muſt remark, that as an ounce of barilha contains 115 grains of mere alkali, the ſolution of it being made in ſix ounces of water, each ounce of the ſolution muſt contain the ſixth part of 115, that is 19 grains; and in the ſame manner it will be found that an ounce of the ſolution of Dantzic ſalt contains 50 grains of mere alkali, that of Cunnamara kelp 2,8 grains, caſhup 15, CLARKE's 21.

THEREFORE 4,2 grains of ſaline ſubſtance of kelp performed the ſame effect,

As 75	of that of Dantzic,
38	of that of barilha,
15	of that of caſhup,
21	of that of CLARKE,
213	of ſoap.

I ALSO tried the power of lime water, but found that three ounces of the ſtrongeſt diſſolved very little of the colouring matter as ſhould be naturally expected, for the three ounces did not contain above 3 grains of lime, nor did the mixture of ſulphur render it more active.

FROM the foregoing experiments we may now deduce the following practical propoſitions:

1ſt, Liver of ſulphur is of all alkaline compounds the ſtrongeſt ſolvent of the colouring matter; next to this the cauſtic vegetable, and after this the cauſtic mineral alkali; the mild vegetable and the mild mineral alkali occupy the laſt place. Sulphur, it is ſaid, leaves a ſtain in linen; but if liver of ſulphur be uſed in the beginning, that is to ſay in bleaching the yarn, the ſtain will probably be removed by the purer alkalies afterwards uſed. Hence the ſolutions of kelp, caſhup and markoſt are advantageouſly uſed in the firſt proceſſes of bleaching, for which Dantzic and ſweet barilha are leſs fit; but ſix tun of kelp will be neceſſary to produce the ſame effect as one tun of caſhup; yet as the former is manufactured at home it deſerves the preference.

2dly, As the alkali manufactured from inland weeds is more powerful than the mineral, Mr. Clarke's is more powerful, or may be rendered ſo, than any imported. It is already ſufficiently cauſtic, and may be converted into liver of ſulphur only by adding $\frac{1}{20}$ of its weight of ſulphur to it when boiling, and thus it is fitted for the firſt proceſſes of bleaching. In its primitive ſtate it is fit for the ſecond proceſs, and by rendering it milder, which may be effected by burning half a buſhel of charcoal in a pan in the ſame room in which its ſolution ſtands, it will be adapted to the laſt proceſſes, in which a leſs active alkali is required.

3dly, Clarke's ſalt converted into liver of ſulphur is preferable to kelp, becauſe this latter, by the preſent manner of manufacturing it, holds charcoal in ſolution; this coaly matter it depoſits on the yarn, and thus leaves a black tinge; whereas Mr. CLARKE's is free from this contamination, to ſay nothing of the far greater quantity of alkali it contains, inſomuch that one tun of CLARKE's is nearly equal to eight tun of kelp. Hence it clearly follows that the linen manufacture ſtands in no ſort of need of foreign ſalts or aſhes for the proceſſes of bleaching.

THE chief defect in Mr. CLARKE's manipulation is the loſs of time during what he calls the *maceration* of aſhes and quick lime; by barely moiſtening them the ſame effect may be produced in nine hours which he expects from their maceration during nine months, and much more lime is uſed than is neceſſary.

DANTZIC pearl aſh contains much more alkali than CLARKE's; this muſt proceed from the ſuperior quality of the aſhes from which it is extracted. Thoſe I received from Mr. CLARKE were exceeding bad; nor do I believe that any crude aſhes can be advantageouſly uſed in bleaching. But if ſome perſons in the different manufacturing counties would allot a few acres to the culture of wormwood and fumitary, I believe their own advantage, as well as that of the public, would thereby be conſiderably promoted. An acre will, I ſuppoſe, ſcarcely produce leſs than four tun of the dry weeds, and each tun will afford nearly 200 weight of aſhes, and each tun of wormwood aſhes will give nearly 1500 weight of unrefined ſalt, or 1300 of the refined.

THE alkali, manufactured after the manner I have indicated in the ſeventh ſection, may not be ſufficiently cauſtic for the earlier operations of bleaching, but by the addition of half a pound of quick lime to every hundred of the ſalt, or of ten pounds for every tun, it will be rendered ſufficiently ſharp. There is no danger that any of the lime will remain in the ley; but if any ſhould it will immediately be diſcovered, and depoſited by the addition of a little of the unmixed ley.